PB-243 834

FALL LAKE, LAKE COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

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July 1975

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NATIONAL EUTROPHICATION SURVEY

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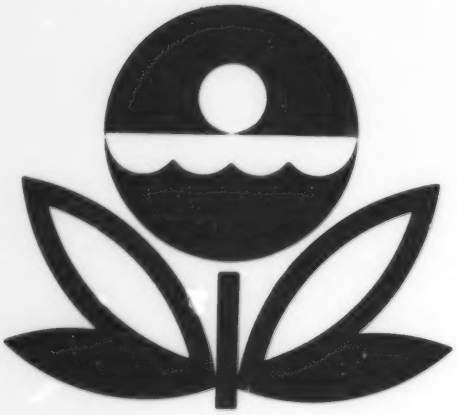

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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REPORT
ON
FALL LAKE
LAKE COUNTY
MINNESOTA
EPA REGION V
WORKING PAPER No. 116

WITH THE COOPERATION OF THE
MINNESOTA POLLUTION CONTROL AGENCY
AND THE
MINNESOTA NATIONAL GUARD
JULY, 1975

CONTENTS

	Page
Foreword	ii
List of Minnesota Study Lakes	iv, v
Lake and Drainage Area Map	vi
Sections	
I. Introduction	1
II. Conclusions	1
III. Lake Characteristics	3
IV. Lake Water Quality Summary	4
V. Literature Reviewed	8
VI. Appendix	9

F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

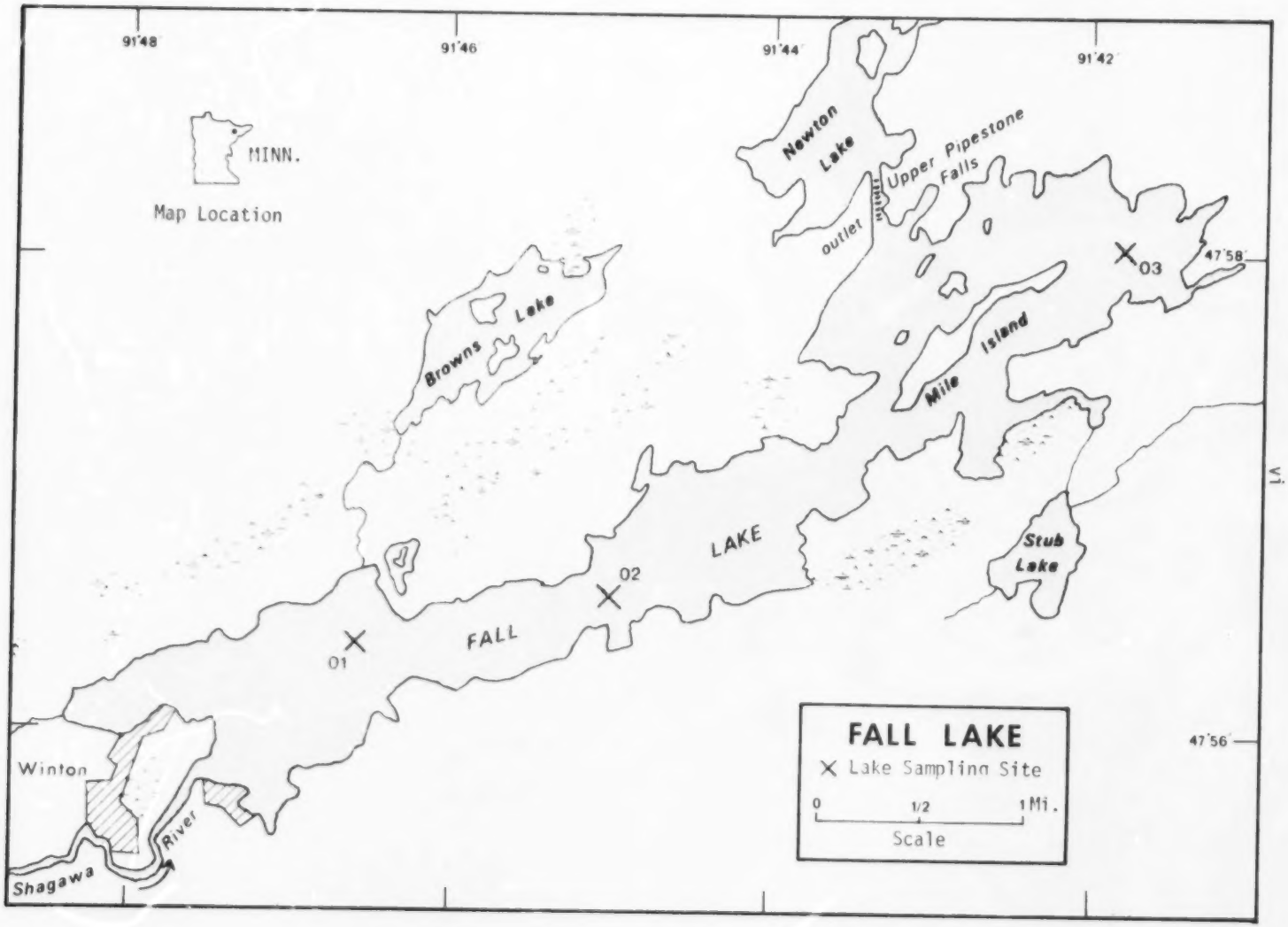
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


91°48
91°46
91°44
91°42
47°58
47°56
MINN.
Map Location
Newton Lake
Upper Pipestone Falls
outlet
Browns Lake
Mile Island
Stub Lake
FALL LAKE
01
02
03
Winton
Shagawa River
FALL LAKE
X Lake Sampling Site
0 1/2 1 Mi.
Scale

FALL LAKE

STORET NO. 2730

I. INTRODUCTION

Fall Lake was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and nutrient sources were not evaluated. Therefore, this report only relates to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data and observations indicate Fall Lake is mesotrophic. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, seven had less mean total phosphorus, eight had less mean dissolved phosphorus, and 13 had less mean inorganic nitrogen. For all samplings of the 60 lakes, 12 had less mean chlorophyll a, and 22 had greater mean Secchi disc transparency. Essentially no depression of dissolved oxygen with depth occurred at any sampling time.

Phytoplankton numbers were quite low, and diatoms were dominant in all samples. No problem aquatic plants or algal blooms were observed by Survey limnologists.

B. Rate-Limiting Nutrient:

A loss of over 20% of the inorganic nitrogen occurred in the algal assay sample between the time of collection and the beginning

of the assay, and the results are not representative of conditions in the lake at the time the sample was taken (10/22/72).

The lake data indicate nitrogen limitation at all sampling times; i.e., the mean N/P ratios were 11/1 or less, and nitrogen limitation would be expected.

III. LAKE CHARACTERISTICS

A. Morphometry*:

1. Surface area: 2,173 acres.
2. Mean depth: 13.0 feet.
3. Maximum depth: 32 feet.
4. Volume: 28,249 acre-feet.

B. Precipitation**:

1. Year of sampling: 37.1 inches.
2. Mean annual: 36.7 inches.

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* MN Dept. of Conservation lake survey map; mean depth by random-dot method.

** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Fall Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake (three in July) and from a number of depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 17 feet at station 1, 18 feet at station 2, and 18 feet at station 3.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized in the following table. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/22/72)		
Temperature (Cent.)	4.6	5.0	5.2	5.2
Dissolved oxygen (mg/l)	10.8	11.0	11.0	11.0
Conductivity (μmhos)	50	51	50	55
pH (units)	7.0	7.0	7.0	7.1
Alkalinity (mg/l)	15	17	17	18
Total P (mg/l)	0.018	0.021	0.020	0.025
Dissolved P (mg/l)	0.011	0.014	0.012	0.021
NO_2 + NO_3 (mg/l)	0.060	0.069	0.070	0.070
Ammonia (mg/l)	0.050	0.051	0.050	0.060
		ALL VALUES		
Secchi disc (inches)	48	62	63	72

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/08/72	1. Melosira	633
	2. Tabellaria	271
	3. Fragilaria	192
	4. Anabaena	170
	5. Asterionella	90
	Other genera	384
	Total	1,740
09/07/72	1. Melosira	434
	2. Lyngbya	325
	3. Kirchneriella	144
	4. Tabelllaria	144
	5. Dinobryon	132
	Other genera	676
	Total	1,855
10/22/72	1. Melosira	1,340
	2. Flagellates	361
	3. Dinobryon	361
	4. Fragilaria	256
	5. Asterionella	136
	Other genera	618
	Total	3,072

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
07/08/72	01	5.9
	02	6.2
	03	14.8
09/07/72	01	6.5
	02	4.9
10/22/72	01	7.0
	02	5.0

V. LITERATURE REVIEWED

Schilling, Joel, 1974. Personal communication (compendium of information on Minnesota lakes). MPCA, Minneapolis.

VI. APPENDIX

APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

273001
47 56 10.0 091 46 38.0
FALL LAKE
27 MINNESOTA

11EPALES 2111202
3 0017 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/08	09 55	0000	20.5	7.6	60	50K	6.70	11	0.030	0.040	0.019	0.011
	09 55	0012	19.8	6.8		50K	6.70	12	0.020	0.030	0.026	0.010
	09 55	0017	19.3	6.1		50K	6.80	13	0.030	0.200	0.033	0.013
72/09/07	13 30	0000			60	60	7.00	12	0.020	0.070	0.025	0.010
	13 30	0004	17.2	8.3		55	7.00	15	0.030	0.060	0.024	0.012
	13 30	0015	16.6	7.8		58	7.00	15	0.030	0.070	0.027	0.016
72/10/22	09 00	0000			48	50	7.00	15	0.060	0.050	0.019	0.011
	09 00	0004	4.6	11.0		50	7.05	16	0.070	0.050	0.025	0.016
	09 00	0016	4.6	11.0		50	7.05	15	0.070	0.060	0.021	0.012

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/08	09 55	0000	5.9J
72/09/07	13 30	0000	6.5J
72/10/22	09 00	0000	7.0J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

273002
47 56 30.0 091 45 00.0
FALL LAKE
27 MINNESOTA

11EPALES
4

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/08	10 25	0000	20.8	8.0	66	50K	7.10	11	0.020	0.140	0.016	0.009
	10 25	0010	20.7	9.8		50K	6.80	11	0.020	0.050	0.021	0.010
72/09/07	13 55	0000			72	58	7.10	16	0.030	0.080	0.018	0.011
	13 55	0004	17.2	8.2		55	7.10	13	0.040	0.080	0.016	0.009
	13 55	0015	17.1	7.9		55	7.00	13	0.040	0.080	0.016	0.009
72/10/22	09 25	0000				50K	7.00	17	0.070	0.050	0.020	0.012
	09 25	0004	5.2	11.0		50K	7.00	18	0.070	0.050	0.020	0.014
	09 25	0012	5.2	10.8		50K	7.05	18	0.070	0.050	0.023	0.021
	09 25	0018	5.2	11.0		55	7.10	17	0.070	0.050	0.018	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/08	10 25	0000	6.2J
72/09/07	13 55	0000	4.9J
72/10/22	09 25	0000	5.0J

K: VALUE KNOWN TO BE LESS THAN INDICATED

J: VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

273003
47 50 00.0 091 40 00.0
FALL LAKE
27075 MINNESOTA

11EPALES
6

2111202
0018 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/08	10 50	0000	21.8	8.0	66	50K	6.90	12	0.040	0.080	0.014	0.009
	10 50	0012	20.6	6.4		50K	6.80	14	0.030	0.060	0.019	0.010
	10 50	0018	19.8	10.6		50K	6.70	13	0.030	0.060	0.019	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/08	10 50	0000	14.8J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR

12.